

## New species of *Cleome* L. (Cleomaceae) from the Northern Territory, Australia

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### ABSTRACT

Four new species of herbaceous flowering plants, *Cleome bundeica*, *C. insolata*, *C. limmenensis* and *C. lophosperma*, all endemic to the Northern Territory, are described. A modified description of *C. microaustratica* H. Iltis, within which *C. limmenensis* was previously included, is provided, as is a key to all formally named species of *Cleome* occurring in the Northern Territory.

KEYWORDS: Cleomaceae, *Cleome*, new species, *C. bundeica*, *C. insolata*, *C. limmenensis*, *C. lophosperma*.

### INTRODUCTION

*Cleome* L. is predominantly a pantropical genus of herbaceous flowering plants and, depending on the circumscription, has between 250 and 280 species (Sánchez-Acebo 2005; Iñda *et al.* 2008; Mabberley 2008), with 14 species, five of which are naturalised, currently recognised from Australia (Craven *et al.* 2010; Australian Plant Census; excluding phrase names). For many years the genus was placed in the family Capparaceae (e.g. Cronquist 1981; Kers 2003), but phylogenetic studies have suggested its placement in either an expanded Brassicaceae (e.g. Judd *et al.* 1999) or in its own family Cleomaceae (e.g. Hall *et al.* 2002; Mabberley 2008). The latter treatment is now widely adopted and followed here.

The most recent treatment of *Cleome* in Australia by Hewson (1982) does not satisfactorily account for the many entities which occur in the Northern Territory, and indeed, elsewhere in Australia. Since her work, the introduced species *C. aculeata* L., *C. gynandra* L. and *C. ruidosperma* DC. have been found in the Northern Territory. Furthermore, following field work in the Top End of the Northern Territory for the *Flora of Darwin* project, it became evident about ten years ago that a number of undescribed taxa exist and that the status and circumscription of several taxa recognised by Hewson needed further examination. However, only two new taxa have been described for Australia since Hewson's account, these being *C. nncifera* subsp. *microphylla* Keighery, which occurs in both Western Australia and the Northern Territory (Keighery 2002), and *C. arenitensis* Craven *et al.* from Western Australia (Craven *et al.* 2010). The name *C. linophylla* (O.Schwarz) Pax & K. Hoffm. has also been reinstated for a species once treated as a variety of *C. tetrandra* DC. (Short 2006).

In this paper four new species are described from the Northern Territory but further work is required to assess the rank and final circumscription of many other taxa, both in the Northern Territory and elsewhere in northern Australia. In several cases better specimens are required before formal naming and description. For example, because of a lack of data regarding petal orientation and staminal characteristics, the author has decided against formally describing a species possibly restricted to the vicinity of Flying Fox Creek in Kakadu National Park. The single specimen by which it is known is housed at the Northern Territory Herbarium (DNA) under the phrase name '*Cleome* sp. Flying Fox Creek (D.J. Dixon 1089 & I.D. Cowie) P.S. Short'. With just five stamens and a seed with a single claiosome, it keys to the *C. tetrandra* group in the key given below. The most distinctive feature of this species is its perennial habit, other Northern Territory specimens referred to this group being annuals.

The above example is one of many specimens held at DNA lacking essential or desirable information required for the identification and description of taxa. Mature seeds are frequently absent from specimens, a critical absence as positive identification may depend on being able to observe features such as testa ornamentation and the number and morphology of claiosomes. Thus, collectors should always endeavour to gather mature seeds. Similarly, to assist in increasing our knowledge of *Cleome* in northern Australia, notes concerning features such as petal orientation, the number and placement of stamens, and the colour of floral organs should be recorded in the field and included on specimen labels. As with seed characteristics, the aforementioned floral organs exhibit many taxonomically useful features which are lost, or difficult to ascertain, in pressed material.

Herbarium abbreviations follow Holmgren *et al.* (1990).

## TAXONOMY

*Cleome bundeica* P. S. Short, sp. nov.

(Figs 1, 2A–D)

A ceteris gregis *C. tetrandrae* cum petalis erectis in proprietatibus sequentibus differt: foliolis ovatis vel obovatis vel oblanceolatis, 5–24 mm longis, 2–10 mm latis, marginibus integris, apice emarginato; petalis interdum spatulatis, basibus unguiformibus, 11–14.5 mm longis, 2–4.3 mm latis, staminibus 6 binatim, par longissimum filamentis 10–14 mm longis, par medianum leviter brevius, par brevissimum filamentis 5–9 mm longis; fructus cylindricus 15–40 mm longus, 2–4 mm diametro, striatus longitudinaliter, pilis glandulis dispersis pedunculis; semina suborbicularia 1.4–1.5 mm, cristis latitudinalibus distinctis, annulis concentricis inconspicuis, elaiosomate singulare grando.

**TYPE.** Australia, Northern Territory, Mt Bunde. In low-lying, inundated loamy soil at base of boulders. P.S. Short 5153 (HOLOTYPE: DNA D172228; ISOTYPES: K, MEL).

**Additional specimens examined.** NORTHERN TERRITORY: Mary River NP, near Mary River Billabong, 24 February 2004, I.D. Cowie 9984 (DNA); Mt Bunde, 14 December 1990, C.R. Dunlop 8762 (DNA); Plum Tree Creek crossing, Kakadu Stage 3, 25 February 1989, K. Menkhurst 258 (DNA); Plum Tree Creek crossing,

Kakadu Stage 3, 25 February 1989, K. Menkhurst 269 (DNA); Mt Bunde region, sandy soil in open woodland near Arnhem Hwy, 3 January 2002, P.S. Short 5134 (CANB, DNA, MEL).

**Description.** Annual herb with ascending to erect branches to approx. 30 cm long, with scattered but prominent indumentum of stalked, rigid glandular hairs.

Leaves mostly 3-foliate, upper ones simple; petioles 2.5–70 mm long, or uppermost leaves subsessile. Leaflets subsessile or petiolule distinct but only to approx. 0.5 mm long; ovate or obovate to oblanceolate, 5–24 mm long, 2–10 mm wide, margins entire, apex emarginate.

Inflorescence terminal raceme of up to approx. 8 flowers, each lower flower usually subtended by small, unifoliate leaf. Sepals linear, lanceolate or oblanceolate, 3.5–5.5 mm long, 0.3–0.9 mm wide, mostly pale green, with scattered stalked glandular hairs. Petals somewhat spatulate, claw-like at base, 11–14.5 mm long, 2–4.3 mm wide, all 4 held somewhat erect, mostly shades of yellow throughout but middle 2 petals with 1 or 2 (lowest may not be well-defined or absent) dark orange or reddish bands at apex of claw and often darker yellow to orange-red below. Stamens 6, filaments free, in 3 pairs, longest pair 10–14 mm long and red-brown, middle pair slightly shorter and red-brown, inner pair 5–9 mm long and yellowish; anthers curved, grey. Gynophore absent. Ovary glabrous or almost so; style red-purple.

Capsules on pedicels 10–18 mm long, cylindrical, 15–40 mm long, 2–4 mm diameter, held at about 90° or less to peduncle, longitudinally striate, with stalked glandular hairs along prominent, slightly raised nerves; beak 8–13 mm long. Seeds 5–20, suborbicular, 1.4–1.5 mm across longest axis, orange-brown but maturing to dark brown or black, cross-ribs distinct, concentric rings faint; elaiosome single, mostly only extending into approx. half or less of the cleft and although prominent never appearing to completely surround funicle.

**Distribution and habitat.** *Cleome bundeica* is endemic to the Top End of the Northern Territory and to date is only known from the vicinity of Mt Bunde, Mary River Billabong and near Plum Tree Creek crossing (Kakadu National Park). It is locally common in eucalypt woodland on sandy soil and sometimes associated with *Pandanus spiralis*.

**Flowering and fruiting.** Recorded for December and January.

**Remarks.** The flowers appear to be bisexual but strongly protandrous, with those observed at the Mt Bunde population having shed their pollen while the ovary and style are, together, only 2–4 mm long.

A further distinctive, undescribed taxon as represented by Short 5154, and collected from a disturbed site across the road from the type locality of *C. bundeica*, is similar to this species. Although the petals tend to be longer, the flowers also have three pairs of stamens, and the seeds are morphologically identical, or nearly so, to those in



Fig. 1. Holotype specimen of *Cleome bundeica* sp. nov. (P.S. Short 5153, DNA D172228).

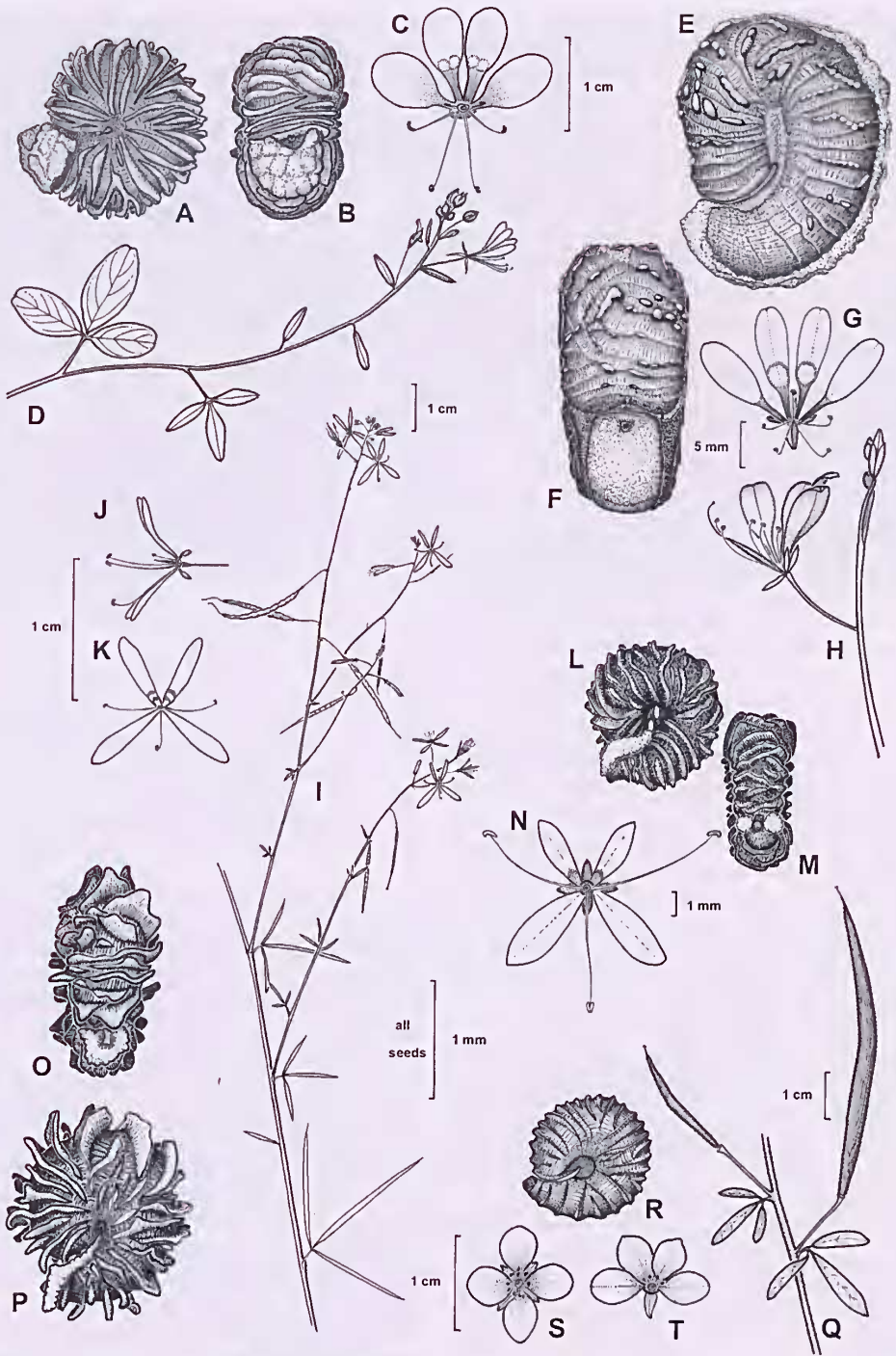


Fig. 2. A–D. *Cleome bundeica* sp. nov.: A, B, seed showing faint concentric rings, prominent cross-ribs and single elaiosome; C, flower with 3 pairs of stamens; D, flowering branchlet, with emarginate leaflets on lowest leaf (A–D, P.S. Short 5153, type). E–H. *Cleome insolata* sp. nov.: E, F, seed showing faint concentric rings, shallow cross-ribs, wart-like protuberances, and extensive elaiosome; G, flower with 5 stamens; H, flower, side view (E–H, P.S. Short 5172, type). I–K. *Cleome tetrandra* DC. s. lat. 1, flowering branchlet; J, K, flower with 4 stamens, uppermost very short (I–K, P.S. Short 5149). L–N. *Cleome linophylla* sp. nov.: L, M, seed with 2 elaiosomes; N, flower with 3 stamens (L–N, P.S. Short 5138). O, P. *Cleome lophosperma* sp. nov.: views of seed showing crest- or shield-like cross ribs and single elaiosome (O, P, P.S. Short 5155, type). Q–T. *Cleome viscosa* auct., probably s. str.: Q, branchlet with leaves and fruit; R, seed, note absence of elaiosome; S, T, flowers showing arrangement of petals (Q–T, P.S. Short 5135).

*C. bundeica*. However, the leaflets are apically acute, not emarginate, are frequently somewhat linear, linear-oblongate or linear-lanceolate and less than 3.5 mm wide, and the capsules are glabrous.

**Conservation status.** There are a few specimens, suggesting that that species is moderately localised, and the size of each of the known populations has not been assessed. Following the IUCN criteria (Standards and Petitions Working Group 2006) for the conservation category of a species, *C. bundeica* is probably best classified as Data Deficient.

**Etymology.** The specific epithet reflects the fact that the species occurs in the Mt Bunde region; the Latinised regional name being Bundeia (the adjectival form being *bundeicus*).

***Cleome insolata* P. S. Short, sp. nov.**

(Figs 2E–H, 3, 4A, B)

A ceteris gregis *C. tetrandrae* cum petalis erectis in propriatibus sequentibus differt: foliola sessilia, linearia, foliolo mediano plerumque multo longius quam foliolis lateralibus, (1.5) 6–17 mm longa, 0.25–0.5 mm lata, glabra; petala interdum spatulata parte tertius basale unguiforme, 10.5–12.5 mm longa, 2.3–3.8 mm lata; stamina 5 interdum inaequalia, 5–10 mm longa; fructus subcylindricus inter semina constrictus, 11–30 mm longus, circa 2 mm latus, striatus longitudinaliter inconspicuus glabrus; semina axe longiore 2.3–2.5 mm, axe breviora 1.7–1.9 mm brunnea vel nigra, cristis latitudinalibus distinctis sed saepe incompletis, annulis concentricis inconspicuis et interdum absentibus, protuberantibus verruciformibus saepe praesentibus; elaiosome singulare, secus paginam extenam extenso.

**TYPE.** Australia, Northern Territory, Woodside Reserve near Solar Village, Humpty Doo, 12°36'49"S, 131°05'38"E. Inundated low sedgeland over laterite gravel with silty loam soil. 31 March 2004. P.S. Short 5172 (HOLOTYPE: DNA D172198; ISOTYPES: AD, K, MEL).

**Additional specimens examined.** NORTHERN TERRITORY: behind Solar Village, Humpty Doo, 18 April 2002, P.S. Short 5139 (DNA).

**Description.** Annual herb with ascending to weakly erect branches to approx. 40 cm long, with mostly sparse indumentum of shortly stalked, rigid glandular hairs.

Leaves mostly 3-foliolate, few upper ones unifoliate; petioles (1.5) 5–8 mm long or uppermost leaves subsessile. Leaflets sessile, linear, with middle leaflet usually manifestly (to twice the length) longer than laterals, (1.5) 6–17 mm long, 0.25–0.5 mm wide, glabrous, margins entire, apex somewhat rounded except for minute mucro.

Inflorescence terminal raceme, of (1) 2–5 flowers. Sepals lanceolate or oblanceolate, 1.8–3.2 mm long, 0.4–1 mm wide, pale green, glabrous or with few stalked glandular hairs. Petals somewhat spatulate, about basal one-third claw-like, 10.5–12.5 mm long, 2.3–3.8 mm wide, all 4 erect, mainly dark yellow but the middle 2 petals with

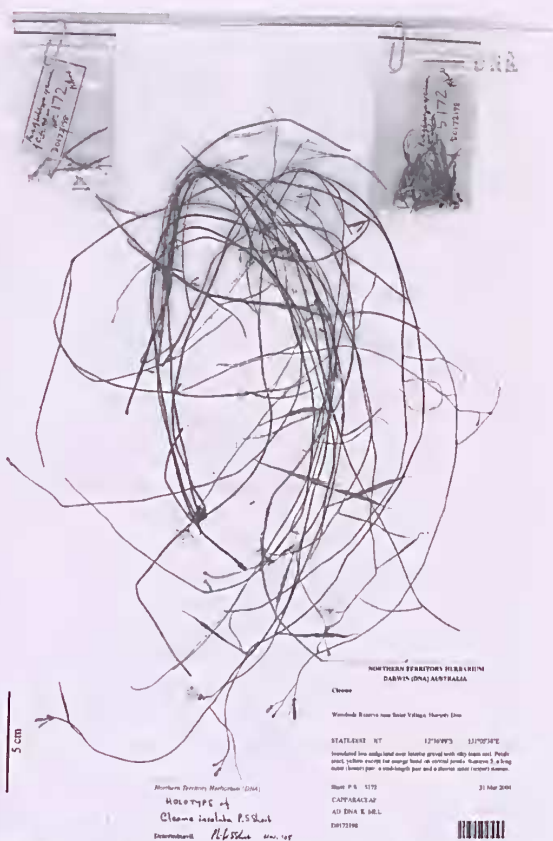


Fig. 3. Holotype specimen of *Cleome insolata* sp. nov. (P.S. Short 5172, DNA D172198).

orange band immediately above claw. Stamens 5, in 2 pairs plus 1 upper stamen; filaments free, unequal, 5–10 mm long, yellow-green with some reddish tint below anthers; anthers 0.8–1 mm long. Gynophore to approx. 1.5 mm long at anthesis, subsequently elongating. Ovary glabrous; style mostly pale whitish but upper part purplish.

Capsules on pedicels 6–9 mm long, gynophores 3.5–6.5 mm long, subcylindrical and usually constricted between individual seeds, 11–30 mm long, approx. 2 mm wide, held at about 90° or less to peduncle, faintly longitudinally striate, glabrous; beak 2–5 mm long. Seeds 1–6, comma-shaped, longest axis 2.3–2.5 mm, shortest axis 1.7–1.9 mm, brown to black, cross-ribs generally distinct but often incomplete, concentric rings very faint and sometimes not apparent, wart-like protuberances often common on surface and frequently following cross-ribs; elaiosome single, extending from hilum as narrow band along outer surface for approx. one-third to total length of seed, filling or mostly filling cleft.

**Distribution and habitat.** *Cleome insolata* is endemic to the Northern Territory. It is known from one population behind the Solar Village near Humpty Doo where most plants grow in inundated sedgeland on silty loam with an overlay of laterite gravel but also on an adjoining,

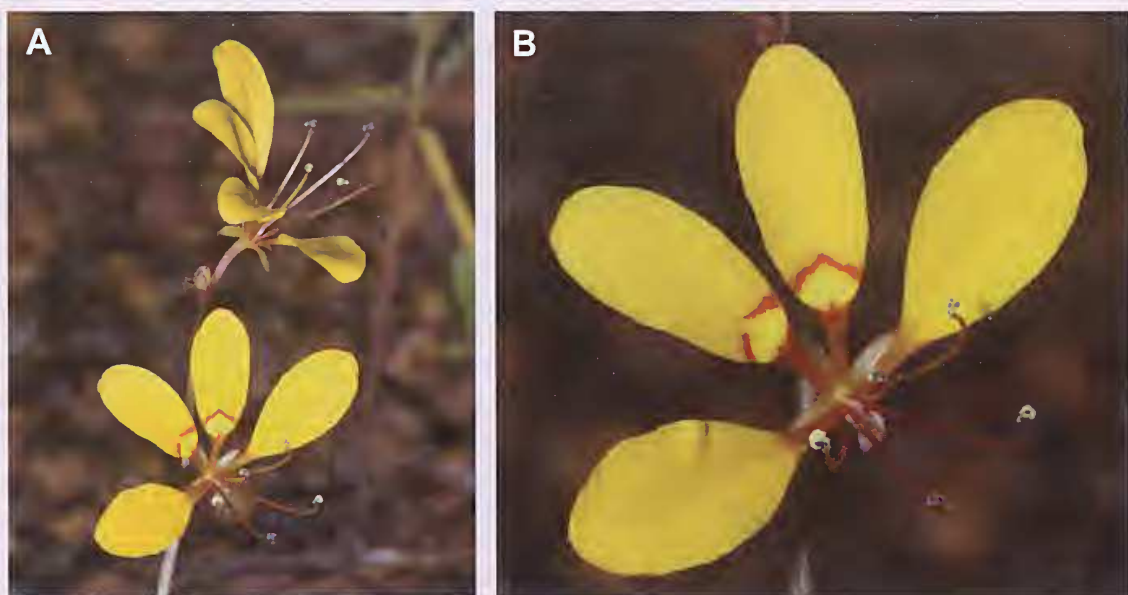


Fig. 4. Photographs of *Cleome insolata* sp. nov. at the type locality: A, inflorescence showing petal colour and arrangement of sepals, petals and stamens (note that an anther is missing from a stamen in the upper flower); B, single flower showing arrangement and colour of floral parts (note that the style is poorly developed, the flowers apparently strongly protandrous). Photographs: Ben Stuckey.

disturbed roadside verge. The population is on the edge of the Elizabeth River catchment, but the extent to which it occurs in the catchment has not been ascertained.

**Flowering and fruiting.** Recorded from March to April.

**Remarks.** The wart-like protuberances on the surface of the seed (Fig. 2E,F) have not been observed in any other Australian species of *Cleome*.

**Conservation status.** On each occasion when the type locality was visited in 2002, 2004 and 2010 probably several hundred plants were present in an area of approx. 4000 m<sup>2</sup> but the extent of this population has not been determined. There is an element of data deficiency associated with this species but as most of the population is on private land it is, arguably, assessed as Vulnerable (criterion D2) under IUCN (Standards and Petitions Working Group 2006).

**Etymology.** The specific epithet, meaning 'exposed to the sun', alludes to both the exposed sedgeland habitat and the locality of the only known population, the Solar Village near Humpty Doo, Northern Territory.

*Cleome limmenensis* P. S. Short, sp. nov.

(Figs 5, 6D)

AC. microaustralasica plantis foliis rigidioribus viscidis, foliolis obtusis ad apicem vel emarginatis, nunquam acutis, mucro apicale, semine elaiosomate utrinque funiculi, nunquam elaiosomate singulare.

**TYPE.** Australia, Northern Territory, McArthur River area. Sandstone plateau near Glyde River, 15°50'17"S, 135°21'24"E, 31 January 1976, L.A. Craven 3569 (HOLOTYPE: DNA A54996; ISOTYPE: CANB, n.v.)

**Synonymy.**

*Cleome microaustralasica* auct. non H.H. Ittis; Hewson (1982, p.p., as to the inclusion of Craven 3569).

**Additional specimens examined.** NORTHERN TERRITORY: Glyde River, near intersection between east and west branches, 21 February 2003, K.G. Brennan 5809 (DNA); Glyde River, west branch, 23 February 2003, K.G. Brennan 5836 (DNA); Limmen National Park, approx. 35 km WNW of Ranger Station, 19 April 2008, I.D. Cowie 11956 (B, DNA, LD, MEL, MO); Broadmere Station, 5 November 2006, S. Legge 12 (DNA); Limmen Gate, 29 May 1996, C. Michell 149 (DNA).

**Description.** Subshrub to approx. 50 cm or more tall, beset with near-sessile (sometimes possibly sessile) to short-stalked glandular hairs approx. 0.6–0.55 (1.5) mm long, apical gland prominent and somewhat spheroidal, hairs common and often dense on stems, leaves, pedicels, calyx and gynoecium, and resulting in parts of plant being manifestly viscid.

Leaves almost sessile to distinctly petiolate; petiole to approx. 14 mm long; mostly 3-foliolate but 2- and 4- or 5-foliolate leaves may also be present; uppermost flower-subtending leaves may be unifoliate, generally smaller than lower cauline leaves. Leaflets obovate to (mostly) oblanceolate, 5–20 mm long, 1.5–6.7 mm wide, entire, variable in length within leaf, in 3-foliolate leaves central leaflet about same length as, or longer than, 2 lateral leaflets; gradually tapering to base, petiolule absent or somewhat poorly defined, to approx. 0.4 mm long; apex obtuse to distinctly emarginated with small, bluntish mucro.

Inflorescence leafy, terminal raceme of approx. 4–6 flowers, each flower being in axil of leaf; pedicels 6–13 mm

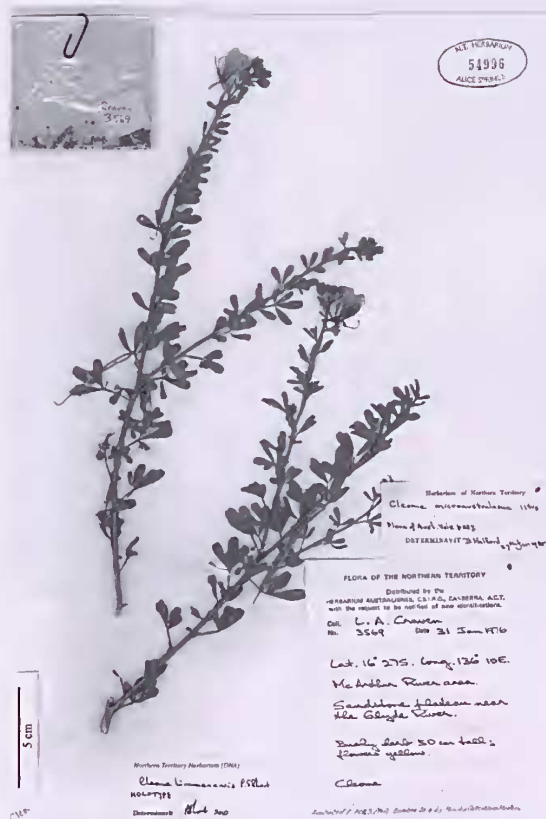


Fig. 5. Holotype specimen of *Cleome limmenensis* sp. nov. (L.A. Craven 3569, DNA A54996).

long at flowering and fruiting. Sepals narrowly elliptic to lanceolate or somewhat obovate, apically acute, 5.6–5.9 mm long, thinly herbaceous and often with prominent venation, outer surface and margins with glandular hairs, inner surface glabrous. Petals oblanceolate, 13.5–22 mm long, 4.4–7.5 mm wide, all 4 assumed to be somewhat erect and not in an x-shaped arrangement, usually gradually tapering towards base and not obviously claw-like in about lower third, seemingly all yellow throughout but on drying often pale yellow, white-yellow or purplish and venation visible. Stamens 9–14; filaments free, 6.2–15 mm long, arrangement not visible in dried specimens, in dried specimens at least basal part and sometimes much of filament purple-brown; anthers 1.8–2 mm long, initially straight but becoming curved. Gynophore absent or almost so. Ovary with numerous stalked glandular hairs; style approx. 6–9 mm long at anthesis, glabrous.

Capsules on pedicels 6–12 mm long and gynophores approx. 1 mm long, subcylindrical, approx. 25–45 mm long, approx. 1.5–3.5 mm diameter, straight to curved, densely glandular-hairy, sometimes appearing to be held erect but probably mostly held below 90° to peduncle; beak approx. 7–14 mm long. Seeds approx. 60, in large capsules, somewhat comma-shaped or suborbicular in outline,

1.5–1.7 mm across longer axis, 1.2–1.45 mm across shorter axis, brown to dark brown-black or black, concentric rings very faint but with many prominent, complete or broken, cross-ribs; claiosomes 2, yellowish or whitish, one on either side of funicle and filling cleft.

**Distribution and habitat.** *Cleome limmenensis* is only known from the Limmen Gate region, including the vicinity of the Glyde River, in the Northern Territory.

All specimens have been collected in sandstone country and it is often, if not always, associated with *Triodia*, e.g. it has been gathered from amongst cracks in the sandstone escarpment where it was growing with *Eucalyptus aspera*, *Acacia minula* and *Triodia microstachya* (Miehell 149).

**Flowering and fruiting.** November to May.

**Remarks.** The species *C. microaustralica* was described by Iltis (1982, *Flora of Australia* 8: 390), the only specimen cited by him being the type specimen. In the same volume of the *Flora*, the treatment of the genus as a whole is ascribed to Hewson (1982) and when citing specimens she also referred Craven 3569, a specimen collected from a sandstone plateau near the Glyde River, to *C. microaustralica*. That gathering is the one here nominated as the type specimen of the new species, *C. limmenensis*.

Collectors have not recorded whether the petals are all erect or arranged in an x-shape and the author has not observed this species in the field. However, the arrangement of the petals on dried specimens, plus an apparent close-relationship with *C. microaustralica*, leaves me in no doubt that they are erect.

There is no mention on labels as to fresh petals being anything other than yellow, while dried petals may be yellow or fade to white or pale purple. In some species, including variants within *C. microaustralica*, there are distinct orange or reddish markings on the claw of each of the two middle petals (or upper petals in the case of species with petals held in a cross). Such colours, although often lost on drying, are not visible on any specimens here referred to *C. limmenensis*.

The holotype specimen has one flower with just five stamens and it is here assumed that some have been lost; the other flower on the specimen has 14 stamens while those in other specimens have no fewer than nine.

Morphologically this species is most similar to *C. microaustralica*. It differs by having more rigid and viscid foliage with apically obtuse to emarginated leaflets, never obtuse to acute apices; by having stalked glandular hairs on the stems which are commonly less than 0.6 mm long, not commonly 1 mm or more long; by having approx. 9–14 stamens per flower, not approx. 14–22; and by the seed having two elaiosomes, not one. The species' distributions are also markedly disjunct. *Cleome microaustralica* was described from Bickerton Island and is also found on Groote Eylandt and sandstone regions in and near Kakadu and Nitmiluk national parks. All such collections are to the north and north-west of *C. limmenensis*.

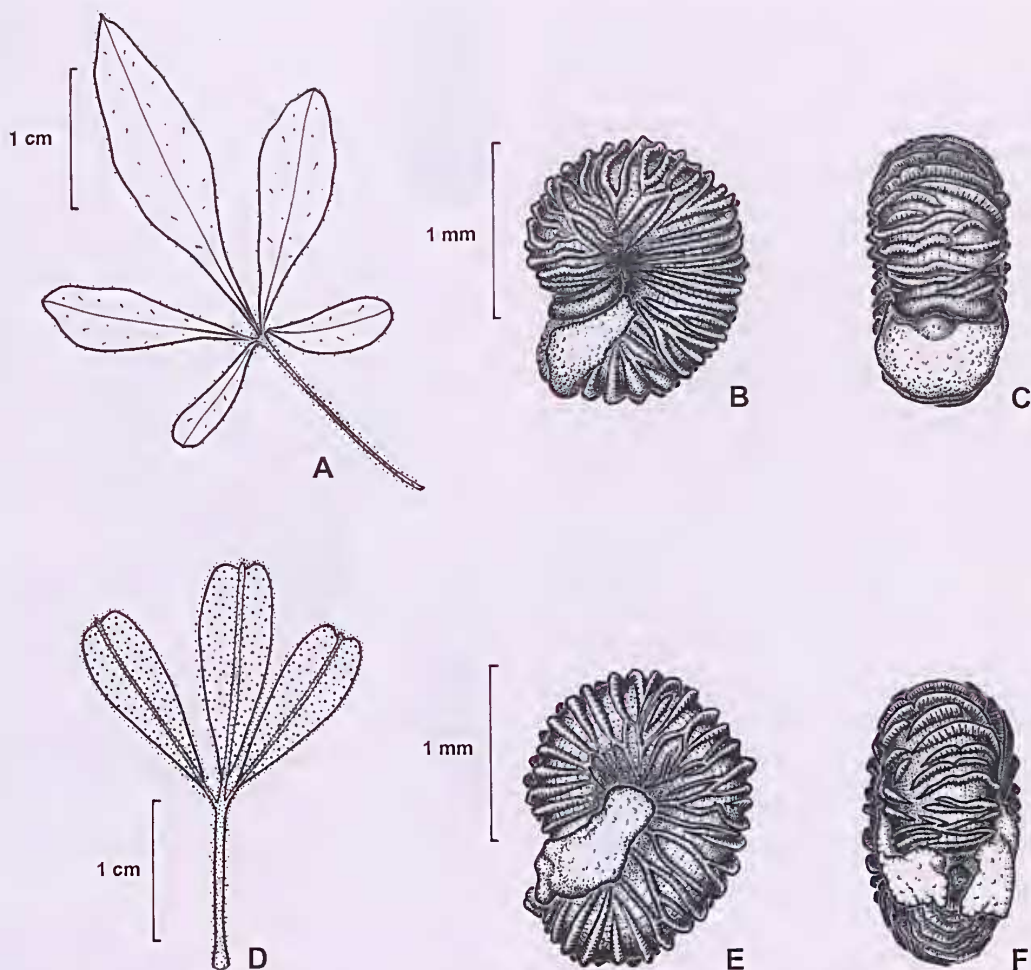


Fig. 6. A–C. *Cleome microaustralica* Ilitis: A, leaf (upper surface) showing the obtuse to acute apices and stalked glandular hairs commonly found in the species; B,C, seed showing prominent cross-ribs and single claiosome only extending part way into cleft (A–C, J. Russell-Smith 1041). D–F, *Cleome limmenensis* sp. nov.: D, leaf (lower surface) showing emarginate apex and glandular hairs; E,F, seed showing prominent cross-ribs and two claiosomes, one on either side of the funicle and filling the cleft (D, L.A. Craven 3569, type; E,F, C. Michell 149).

**Conservation status.** *Cleome limmenensis* is only known from a few localities spread over an area less than 200 km long but in relatively remote and rarely accessed sandstone country. As such, it is highly unlikely to be threatened by human activities. However, lack of data on its biology, number and extent of individual populations suggests that under the IUCN criteria (Standards and Petitions Working Group 2006) for the conservation category of a species, *C. limmenensis* should be classified as Data Deficient.

***Cleome lophosperma* P. S. Short sp. nov.**

(Figs 20,P, 7)

A ceteris gregis *C. tetrandrae* petalis quattuor in cruce dispositis, semine cristis grandissimis latitudinaliter ordinatis, claiosomate singulare differt. Haec species

plerumque glabra est, plerumque foliis trifoliatum, staminibus (3) 4 (5) in quoque flore.

**TYPE.** Australia. Northern Territory, approx. 1 km E of Girraween Road (sealed) along dirt road following power lines, 12°31'30"S, 131°06'54"E. Low, open woodland with *Grevillea pteridifolia*; deep sand. 6 March 2003, P.S. Short 5155 (HOLOTYPE: DNA D172220; ISOTYPES: AD, BRI, MEL).

**Additional specimens examined.** NORTHERN TERRITORY: Arnhem Hwy, 8 km E of Adelaide River, 7 January 2003, R.K. Harwood 1230 (DNA); Koolpinyah sand pit, Howard River, 17 January 1979, M.O. Rankin 1695 (BRI n.v., CANB n.v., DNA, K n.v.); approx. 1 km E of Girraween Road (sealed section) along dirt road near T-junction with road heading north, 21 December. 2001, P.S. Short 5130 (AD, DNA); approx. 8 km SE of Adelaide River along Arnhem Hwy, 11 December 2002, P.S. Short

5143 (AD, CANB, DNA, MEL); 12.5 km W of Corroboree Park along Arnhem Highway, 19 February 2003, P.S. Short 5144 (DNA, MEL); Howard River area, Whitewood Road, 29 December 2009, B. Stuckey 478 (DNA).

**Description.** Annual herb with ascending to erect branches to approx. 40 cm long, mostly glabrous but with occasional stalked, rigid, multiseptate whitish or purplish glandular hairs to approx. 0.4 mm long on branches and leaves.

Leaves. Basal and mid-cauline leaves mostly 3- or rarely 5-foliate, upper and sometimes some basal leaves unifoliate; petioles approx. 1–40 mm long and at least upper leaves sessile or nearly so. Leaflets subsessile, linear-oblancheolate or linear-elliptic, with middle leaflet much longer than laterals, all leaflets (2) 4–35 mm long, 0.3–2 (4) mm wide, glabrous or with few scattered hairs as on stem and branches, margins entire and slightly inrolled, apically tapering to small, bluntish mucro.

Inflorescence terminal, leafless raceme of 5–14 flowers; pedicels at flowering approx. 6–7 mm long. Sepals ovate or triangular to narrowly triangular, 1.1–2 mm long, 0.3–0.5 mm wide, pale green or whitish and usually at least slightly purplish, glabrous. Petals oblancheolate and gradually tapering to base, 5.4–7.2 mm long, 1.2–1.9 mm wide, arranged in an x with 2 petals held erect and 2 pointing down; upper petals mainly yellow, each with orange to slightly reddish band towards base and tending to be darker yellow beneath band; lower petals entirely yellow. Stamens (3) 4 (5); filaments free, 3.5–5.8 mm long, unequal and with one shorter than the others, yellow-green; anthers curved, 0.5–1 mm long, purplish but tending to brown on drying. Gynophore absent. Ovary glabrous.

Capsules on pedicels 5.5–12 mm long, subcylindrical, 14–34 mm long, approx. 1.5 mm wide, mostly greenish to pale brown-purple and sometimes with one or both lines of dehiscence distinctly purple, glabrous, usually constricted around individual seeds, held at about 90° or less to peduncle, faintly longitudinally striate; beak 2–4 mm long. Seeds (2) 5–22, comma-shaped or suborbicular in outline, 1.6–2.3 mm long across longest axis, 1.3–1.8 mm across shortest axis, pale brown, grey or blackish, cross-ribs very prominent, being crest-like, concentric rings somewhat indistinct to distinct; elaiosome single, whitish, and extending into approx. half or all of cleft on both sides of seed, tending to be most prominent immediately to the sides of funicle, not surrounding funicle but forming along its outer side.

**Distribution and habitat.** *Cleome lophosperma* is endemic to the Top End of the Northern Territory, where it occurs in the general vicinity of Koolpinyah and further east towards the Adelaide River crossing of the Arnhem Highway. It has been recorded from low-lying, seasonally inundated low open woodland dominated by *Grevillea pteridifolia*, *Melaleuca nervosa* and *Pandanus spiralis*, with *Dapsilanthus* sometimes common in the herb understorey; always growing in sand or very sandy loam.

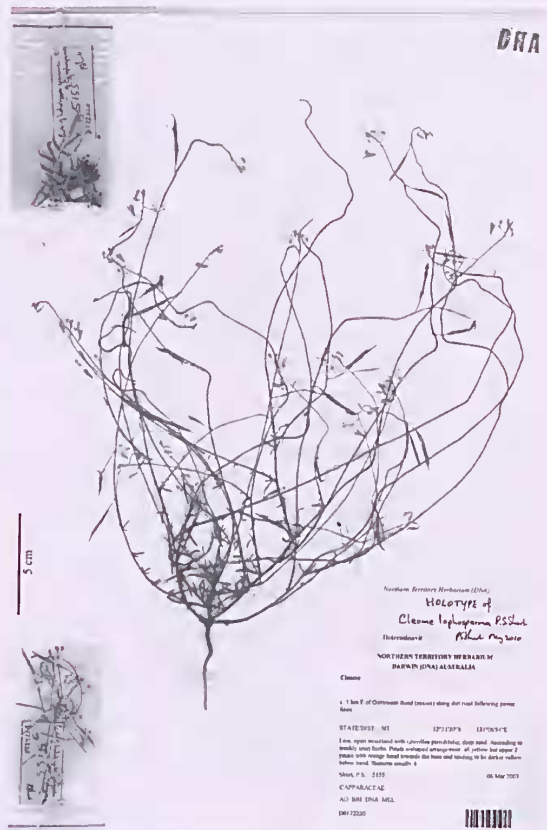


Fig. 7. Holotype specimen of *Cleome lophosperma* sp. nov. (P.S. Short 5155, DNA D172220).

**Flowering and fruiting.** December to March.

**Remarks.** Included within the circumscription of this species are two collections (Harwood 1230, Short 5143) which have immature seeds and an undeveloped elaiosome, but which appear to be developing prominent cross ribs. Examination of immature and mature seeds from single plants in other collections indicates that the elaiosome is late-developing in the species. Therefore, I have no doubt that the aforementioned specimens belong to *C. lophosperma*.

*Cleome tetrandra* s. str., as its name suggests, has four stamens, a feature it shares with *C. lophosperma* and a number of other undescribed entities which I refer to the *C. tetrandra* group. The question must be asked as to whether *C. tetrandra* and *C. lophosperma* are distinct.

Candolle (1824) indicated that he described *C. tetrandra* from a specimen in the Joseph Banks' herbarium in BM. At the Natural History Museum, London website it is recorded that in 1985 the taxonomist, H.H. Iltis, identified a specimen gathered by Banks and Solander and numbered BM 629036 as the holotype specimen of the name *C. tetrandra*. I have not viewed this specimen. Candolle's (1824) description is brief and of little value. It lacks any description of the seed, but if accurate then material of *C. lophosperma* must

be excluded from *C. tetrandra* s. str. by virtue of plants being described as glabrous (they are mostly glabrous in *C. lophosperma*) and having 3-foliate leaves in which the leaflets are 2–3 lines long (i.e. about 4.2–6.3 mm long). In *C. lophosperma* they are 4–35 mm long. Candolle (1824) also stated that the capsules are sessile, which they are not in *C. lophosperma*, but it may be that he was referring to the lack of a gynophore, not the lack of a pedicel.

There is a specimen held in the Candolle Prodrum Herbarium (G-DC) (seen on IDC microfiche 800/121) with an annotation indicating that it was sent from the Banks' herbarium by Robert Brown in 1819. If it is an isotype specimen then the two plants which comprise it are not in agreement with the description as, although the photograph lacks a scale, the leaflets appear to be in accord with *C. lophosperma* in size and shape and, although plants are fewer-branched and have apparently ascending branches, are not unduly dissimilar in general appearance to specimens of *C. lophosperma*.

As *C. lophosperma* is quite localised, has a distinctive combination of characters and seeds with uniquely crest-like cross ribs (Fig. 2O,P) not seen in other Northern Territory material, and because the type of *C. tetrandra* was collected from a coastal or near-coastal location in Queensland, I do not doubt that it is a distinct species.

**Conservation status.** Unless it is in full bloom, this species can be difficult to detect amongst other herbs and thus its range may be wider than currently known. Lack of a species-specific survey in areas of potential habitat – of which there is much – and the inconspicuous nature of the flowers suggest that in regard to the IUCN criteria (Standards and Petitions Working Group 2006) for the conservation category of a species, *C. lophosperma* is best classified as Data Deficient.

**Etymology.** The epithet *lophosperma* is a Greek compound word derived from *lopho-* (crest-) and *-sperma* (seed) and it refers to the distinctive, crest-like cross-ribs of the seed.

***C. microaustralis* H. H. Iltis, 1982**

(Fig. 6A–C)

**TYPE.** Australia, Northern Territory, South Bay, Bickerton Is., Gulf of Carpentaria. 14 June 1948, R.L. Specht 552 (HOLOTYPE: K, n.v.; ISOTYPES: AD, CANB n.v., GH n.v., PERTH n.v., US n.v., WIS n.v.).

**Synonymy.**

*Cleome viscosa* auct. non L.: Benth., *Flora australiensis* 1: 91 (1863), p.p.

**Illustrations.** Brennan, *Wildflowers of Kakadu* 22 (1986), as *C. viscosa*; Brock, *Top End Native Plants* 122 (1988 and subsequent reprints, incl. as *Native Plants of Northern Australia*), as *C. viscosa*.

**Specimens examined.** NORTHERN TERRITORY: approx. 16 km S of Oenpelli, 15 February 1973, L.G. Adams & C.R. Dunlop 2980 (DNA); near (NW of) Katherine, 26 April 1947, S.T. Blaké 17496 (DNA); Kakadu

National Park, Little Nourlangie Rock, 1 March 2004, K.G. Brennan 6121 (DNA); Kakadu National Park, Graveside Gorge, 19 March 2004, K.G. Brennan 6210 (DNA); upper Jim Jim Creek, 15 March 2009, K.G. Brennan 7904 (DNA); Mt Callanan, 11 April 1977, G. Brown (DNA D11397); Katherine Gorge, 16 January 1967, N. Byrnes 68 (DNA); Katherine Gorge, 5 May 1968, N. Byrnes 677 (DNA); Waterfall Creek, South Alligator River, 5 January 1972, N. Byrnes 2447 (DNA); Kakadu Hwy, Moline Creek, 19 March 1987, M.J. Clark 832 (DNA); 4 km NNE of Koongarra, near Buffalo Springs, Mt Brockman, 22 May 1980, L.A. Craven 5769 (DNA); Mt McMinns Stn, E of turnoff to Roper Bar, 20 March 2002, D.J. Dixon 1007 (DNA); Little Nourlangie Rock, 17 March 1978, C.R. Dunlop 4709 (DNA); approx. 70 km NE of Pine Creek, El Sharana Road, 5 March 1985, C.R. Dunlop 6767 (DNA); Kakadu National Park, 22 April 1990, C.R. Dunlop 8578 (DNA); 17 km SE of Twin Falls, 20 March 1988, R. Fensham 696 (DNA); Jim Jim Falls, 3 December 1989, P.I. Forster 6124 (DNA); Nourlangie Rock, 4 July 1973, N.M. Henry 877 (DNA); Mt Brockman outlier, 15 km SE of Jabiru, 20 April 1989, R.W. Johnson 4654 (DNA); approx. 7.5 miles SE of Mt Gilruth, 28 February 1973, M. Lazarides 7925 (DNA); Bickerton Is., South Bay, 7 May 1993, G.J. Leach 3717 (DNA); Nitmiluk National Park, 8 February 2001, C.R. Michell 3370 (DNA); 25 km from Jabiru towards Oenpelli, 20 May 1988, A.A. Munir 5775 (DNA); Katherine Gorge, 27 April 1972, J. Must 976 (DNA); UDP Falls, 13 January 1973, J.L. McKean B869 (DNA); Plum Tree Creek crossing, Kakadu National Park, 1 February 1989, K. Menkhurst 235 (DNA); near Cannon Hill, Kakadu National Park, 14 March 1983, J. Russell-Smith 523 (DNA); Kakadu National Park, 29 January 1984, J. Russell-Smith 1041 (DNA); upper East Alligator River region, 25 April 1988, J. Russell-Smith 5350 (DNA); Kakadu National Park, Nawalandja, 16 April 1992, J. Russell-Smith 8642 (DNA); Kakadu National Park, 10 km ESE from the junction of Katherine River and Gimbat Creek, 18 Apr. 1990, A.V. Slee & L.A. Craven 2542 (DNA); Bardalumba, Groote Eylandt, 31 May 1977, J. Waddy 693 (DNA); gorge between Twin Falls & Jim Jim Falls, 24 March 1984, G. Wightman 1300 (DNA).

**Description.** Herb or subshrub to approx. 1 m tall, beset with stalked glandular hairs and somewhat viscid, hairs variable in length, approx. 0.2–1.5 (2.3) mm long.

Leaves mostly 3–5 (6)-foliolate, upper ones unifoliate; petioles mostly 10–50 (75) mm long, upper unifoliate leaves often sessile or almost so and approx. 10 mm long and 1 mm wide. Leaflets sessile or shortly petiolulate, elliptic to narrowly elliptic, lanceolate to narrowly lanceolate or linear-lanceolate, or oblanceolate to narrowly oblanceolate, 10–50 (57) mm long, (1) 3–9 (13) mm wide, entire, apex commonly acute but sometimes obtuse and even slightly emarginate with obtuse to acute leaves often on the one plant, glandular hairy and sometimes slightly viscid.

Inflorescence terminal raceme of 4–10 or more flowers, each flower subtended by 1 leaf, leaves reducing in size and becoming single foliate and bract-like towards apex; pedicels to approx. 12 mm long, with stalked glandular hairs. Sepals narrowly elliptic, lanceolate, narrowly oblanceolate or somewhat linear, 10–15 mm long, 1–2.3 mm wide; apex acute to acuminate, green or reddish and often manifestly so in about lower half or more, glandular hairy. Petals somewhat spathulate, 15–23 mm long, 4.7–8.5 mm wide, all 4 erect, with 1 claw approx. one-third length of petal, mostly yellow throughout and pale yellow or whitish on drying but at least basal part of claw may be red-orange, occasionally 1 or 2 red-orange bands may be present in middle 2 petals (see below). Stamens 12–22, unequal; filaments free, 10–23 mm long, longest in flower approx. 5–8 mm longer than shortest, commonly reddish or purple; anthers 1.8–2 mm long, becoming curved. Gynophore obscure at anthesis. Ovary glandular-hairy.

Capsules on pedicels 8–17 mm long and with gynophores to approx. 2 mm long, subcylindrical, 20–110 mm long, approx. 2–3 mm diameter, commonly held well above 90° to peduncle, straight to distinctly curved, densely glandular-hairy with hairs often all short but sometimes highly variable in length, approx. 0.2–0.65 mm long; beak 7–14 mm long. Seeds approx. 80 or more, in large capsules, somewhat comma-shaped or suborbicular, 1.1–1.5 mm across longest axis, 0.95–1.2 mm across shortest axis, brown, dark red-brown, or dark purple-brown, concentric rings absent or faint but with prominent cross-ribs; elaiosome single, prominent and thick and mostly restricted to around funicle and extending less than halfway into cleft.

**Distribution and habitat.** *Cleome microaustratica* was described from Bickerton Island and is also found on Groote Eylandt and sandstone regions in and near Kakadu and Nitmiluk national parks. All such collections are to the north and north-west of *C. limmenensis*, to which it appears most closely related.

It is a species of sandstone outcrops commonly dominated by eucalypt–spinifex woodland.

**Flowering and fruiting.** Recorded from January to July.

**Remarks.** As defined here, the species is quite variable and specimen records indicate a disjunction of 250 km or more between populations from Groote Eylandt and Bickerton Island (the type locality) and other collections from central Arnhem Land. There is considerable variation in leaf shape and petiole length but I suspect that, at least in part, this reflects variation in habitat and whether plants have resprouted after fire. Hair length varies considerably within a plant but is particularly variable in Brennan 6121, where the shortest hairs on the stems are only about 0.15 mm long and the longest nearly 2.5 mm. Furthermore, as noted in the description above, all four petals are usually yellow throughout except for a darkening of the claw. However,

the illustration in Brennan (1986: 22) shows two red-orange bands on each of the inner petals, there being a band just above the claw and, above that, a narrower, irregular, semicircular band. In Brennan 7904 the two inner petals have just a single, narrow, irregular orange-red band above the claw.

**Conservation status.** *Cleome microaustratica* is widespread in the central and eastern parts of Arnhem Land, including Kakadu and Nitmiluk national parks, and following the IUCN criteria (Standards and Petitions Working Group 2006) for the conservation category of a species should be classified as one of Least Concern.

#### KEY TO SPECIES OF *CLEOME* FOUND IN THE NORTHERN TERRITORY

This key is to species whose names are accepted under the rules of the International Code of Botanical Nomenclature (McNeil *et al.* 2006). Thus, it excludes the distinctive perennial entity from Flying Fox Creek referred to above. It also excludes one of several taxa which will key to the *C. viscosa* group, this being a large-flowered, coastal entity to which the name *Polanisia viscosa* var. *grandiflora* Benth. (Bentham 1963) may or may not apply. The combination does not exist in *Cleome viscosa* while the combination *C. grandiflora* (Benth.) F. Muell. (1886) is illegitimate, being a later homonym. The circumscription of the latter taxon is somewhat unclear but similar specimens are found along much of the northern Australian coastline, including many near-coastal islands off the Top End, where it commonly frequents sand dunes. It is curated in the Northern Territory Herbarium under the phrase-name '*Cleome* sp. large coastal (Barritt 1797)'.

A specimen which does not key out as a recognised species should key to either the *C. viscosa* species group or the *C. tetrandra* species group. Specimens referred to the *C. viscosa* species group have seeds which lack an elaiosome. Usually, if not always, they have more than ten stamens per flower – none of which are held in distinct pairs – and petals appearing to be held in a circle (albeit a cross-shaped arrangement) or half-circle (Fig. 1S,T). Specimens attributed to the loosely-defined *C. tetrandra* group, which includes *C. bundeica*, *C. insolata*, *C. linophylla* and *C. lophosperma*, should have seeds with one or two elaiosomes, fewer than ten stamens – with two or more usually held in distinct pairs – and all four petals either held erect (as in Fig. 1C,G) or arranged in a cross, with two pointing up and two down (as in Fig. 1K,N).

Species marked with an asterisk are naturalised weeds. Illustrations of taxa additional to those described in this paper are included in Fig. 1 to show some of the morphological variation referred to in the key.

- 1a. Leaves in basal rosette ..... *C. oxalidea*
- 1b. Leaves cauline..... 2
- 2a. Stipules spinescent..... 3
- 2b. Stipules absent or not spinescent ..... 4
- 3a. Petals less than 10 mm long; leaves 3-foliolate.....  
..... \**C. aculeata*
- 3b. Petals more than 10 mm long; leaves 5–8-foliolate .  
..... \**C. sesquiorigalis*
- 4a. Stems and leaves with sessile or near-sessile glandular  
hairs, when visible their stalks are stout and rarely  
as long or very slightly longer than the length of  
the globular heads (Tanami region; leaflets obovate,  
2.5–9 mm long; petals erect; stamens 6 in 3 pairs) .  
..... *C. uncifera*
- 4b. Stems and leaves glabrous or with a sparse to dense  
cover of distinctly-stalked glandular hairs, if sessile  
or near-sessile glandular hairs present then so too are  
long-stalked glandular hairs in which the stalk is at  
least twice the length of its globular or subglobular  
head ..... 5
- 5a. Stamens connate in at least their lower half ..... 6
- 5b. Stamens free or almost so ..... 7
- 6a. Petals 50–100 mm long ..... *C. cleomoides*
- 6b. Petals 5–20 mm long..... \**C. gynandra*
- 7a. Petals mostly or only coloured pink or mauve .....  
..... \**C. rutidosperma*
- 7b. Petals mostly or only coloured yellow or white ..... 8
- 8a. Seeds lacking elaiosomes; flowers probably always  
with the four petals erect and forming a semi-eirele  
or near-complete eirele around the ovary (Fig. 1S,T)  
..... *C. viscosa* group
- 8b. Seeds with 1 or 2 elaiosomes; flowers with the petals  
erect (Fig. 1C,D,G,H) *or* two petals erect and two  
pointing down (Fig. 1J,K,N)..... 9
- 9a. Flowers with all petals erect (Fig. 1C,D,G,H).....  
..... 10
- 9b. Flowers with two petals erect and two pointing down  
(cross-shaped arrangement) (Fig. 1J,K,N).....  
..... (*C. tetrandra* group) 14
- 10a. Stamens (9) 12 to approx. 20 ..... 11
- 10b. Stamens 5 or 6 (7) ..... (*C. tetrandra* group) 12
- 11a. Seed with 2 elaiosomes, one on either side of the  
funicle; leaflets with obtuse or emarginate apices, at  
least the upper leaves often very viscid (Fig. 2D–F)  
..... *C. limmenensis*
- 11b. Seed with a single elaiosome extending around the  
funicle; leaflets with obtuse to acute apices, the upper  
leaves usually not manifestly viscid (Fig. 2A–C) ....  
..... *C. microaustralica*
- 12a. Seeds with wart-like protuberances on their surface  
and a single elaiosome extending around the outer  
surface (Fig. 1E–H)..... *C. insolata*
- 12b. Seeds lacking wart-like protuberances, elaiosome(s)  
not as above..... 13
- 13a. Plants with leaflets ovate or obovate, 5–24 mm long,  
2–10 mm wide, emarginate; stamens 6 in 3 pairs;  
elaiosome single (Fig. 1A–D)..... *C. bundeica*
- 13b. Plants lacking the above combination of characters.  
..... *C. tetrandra* group
- 14a. Leaves entire (1-foliolate) and linear; elaiosomes 2  
(Fig. 1L–N) ..... *C. linophylla*
- 14b. Leaves 3- or 5-foliolate, at least near the base of the  
plant, entire leaves may also be present; elaiosomes  
probably only 1, perhaps 2 in some entities ..... 15
- 15a. Seeds with very prominent, crest-like cross ridges  
(Fig. 1O,P) ..... *C. lophosperma*
- 15b. Seeds with low cross-ridges..... *C. tetrandra* group

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